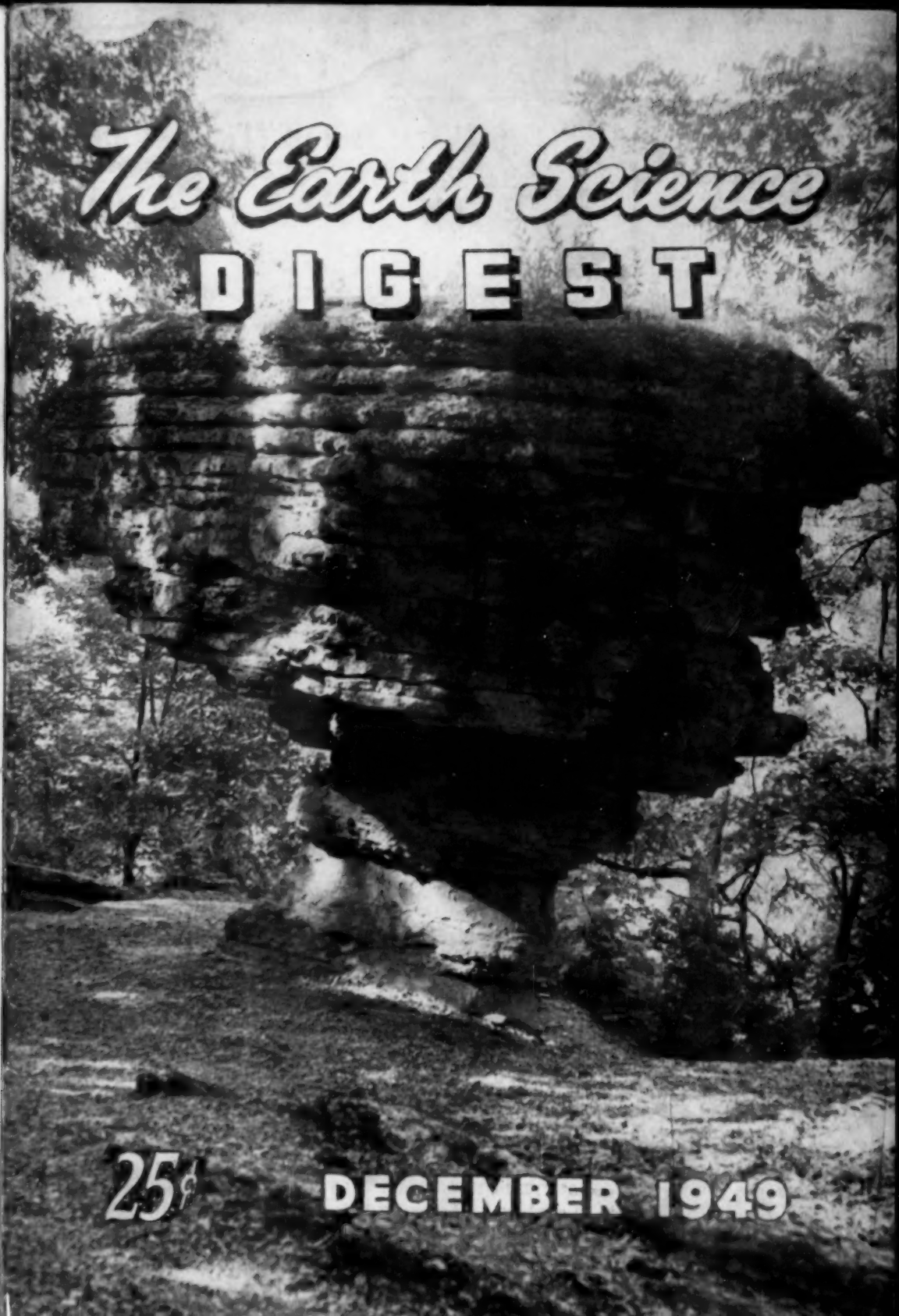
The Earth Science
DIGEST
25¢
DECEMBER 1949

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Revere, Massachusetts

Vol. IV DECEMBER, 1949 No. 5

A magazine devoted to the geological sciences.

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Published Monthly by The Earth Science Publishing Company, 77 Victoria St., Revere, Mass. Entered as second class matter April 12, 1948 at the post office at Boston, Massachusetts, under the Act of March 3, 1879.

S. ALBERT EISENBERG, Publisher

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American Association for the Advancement of Science, Section E, 116th Annual Meeting. Dec. 29-30, 1949. Hotel Statler, New York.

Earth Science Institute, Annual Meeting. March 17, 1950. Boston.

Conference on the Teaching of the Earth Sciences in the Secondary Schools. March 17-18, 1950. Boston.

National Speleological Society, National Convention. March 31-April 2, 1950. Dodge Hotel, Washington, D. C.

American Association of Petroleum Geologists, 34th Annual Meeting; Society of Economic Paleontologists and Mineralogists, 23rd Annual Meeting; Society of Exploration Geophysicists, 19th Annual Meeting. April 23-28, 1950. Chicago.

DRILL CORES KEPT IN MINES BUREAU REFERENCE "LIBRARIES"

WASHINGTON, Nov. 5 — Permanent and tangible records of geologic information essential to a national inventory of mineral resources are now kept in mineral reference libraries — core-storage warehouses — set up and operated by the Bureau of Mines at seven places throughout the United States and Alaska.

Drill cores — cylinder-shaped specimens bored out of the earth with hollow drills — obtained from Government and private investigations of ore deposits in various parts of the country are stored in the core libraries, along with complete records of each ore sample. The seven core-libraries are at Bluemont (Mt. Weather), Va.; Rolla, Mo.; Salt Lake City, Ut.; Reno, Nevada; Tucson, Arizona; Albany, Ore.; and Fairbanks, Ala.

Becoming more valuable each year, these records of numerous surveys and studies made in the search for exact knowledge of the Nation's mineral reserves are useful as guides in planning the development of more promising ore deposits, according to Bureau Director James Boyd. They are also helpful in evaluating the national critical and essential mineral situation and the industrial possibilities of specific areas.

Expanding economic needs and technologic advances—only gleams in the eyes of research scientists not so long ago — are among the conditions which have made minera's formerly regarded as valueless, or at least uneconomical to use or treat, all but invaluable today.

At the Bureau's Mississippi Valley Experiment Station, at Rolla, Mo., for instance, thousands of old mineral samples are now being rechecked for radioactivity. These samples, originating mostly in Missouri, Arkansas, Indiana, Illinois, Kansas and Oklahoma, were stored away several years ago.

Significant information often has been lost in the past when cores and cuttings were discarded, thrown away, after mineral deposits had been sampled and analyses made in laboratories.

Director Boyd and other officials of the Bureau, foreseeing the likelihood that future economic and technical changes may be as drastic as those recently experienced, devised the core-libraries as a means of enabling scientists to continue their studies of core specimens collected during investigations. They point out as an instance that formerly ore containing less than 3 or 4 per cent copper could not be mined profitably, while now ore containing 1 per cent copper is commercially usable.

Formerly only logs or records were kept of core analyses, the cores themselves being thrown away. With the cores, or vertical halves, of these drill core samplings at hand, the ores may be reassayed, disputed or unclear details studied and reappraised, and other tests, such as spectrographic and microscopic, carried on.

Engineers point out that geologic information sometimes is of no practical value when obtained, but later it may prove important. They say that these cores may serve as "horizon markers" in later studies because geological formations hold a direct relationship to ore zones. Given the geological setting, they note, the geological structure serves as one of the basic guides in the search for ore. The emplacement, form and extent of many ore deposits appear to be largely controlled by geological structure.

SOUTH-CENTRAL NEW MEXICO'S SINK-HOLES AND CRATERS

ALFRED M. PERKINS

In an open desert expanse known as the La Mesa Plain, which lies approximately thirty-five miles southwest of Las Cruces, New Mexico, is an extensive area of sink-holes, fissures, lava flows, and craters. These sink-holes are collectively and rather indiscriminately referred to locally as "The Sunken Mesa".

Of the many sink-holes in the area, three are outstanding because of their size, and of these there are two which dominate because of their rugged grandeur and the interesting mode of their formation. The largest hole is Phillips Hole, which is some three miles in length and two miles in width, but since its depth is but approximately fifty feet it is not spectacular and can be briefly described as a large, saucer-like depression of no compelling interest. Kilbourne Hole (Figs. 1-2) is by far the most interesting from any standpoint except perhaps beauty. It is approximately two miles in length and one and one-quarter miles in width, its floor being about two hundred and fifty feet below the level of the plain. It is nearly completely circled by a rim which, at its highest point, stands about the same height above the plain. Hunt's Hole is roughly circular, about one and one quarter miles in diameter, and is about eighty feet deep. Its rim is incomplete, low, and somewhat unimpressive in comparison to that of Kilbourne.

Fig. 1. Airplane view of Kilbourne Hole and Hunt's Hole.

KILBOURNE HOLE

To explain the formation of Kilbourne Hole is to cover the succession of events which created the others, although certain of the phenomena which contributed to the formation of Kilbourne were only partially effective or entirely lacking elsewhere.

The story may well begin at a time when a broad, deep valley

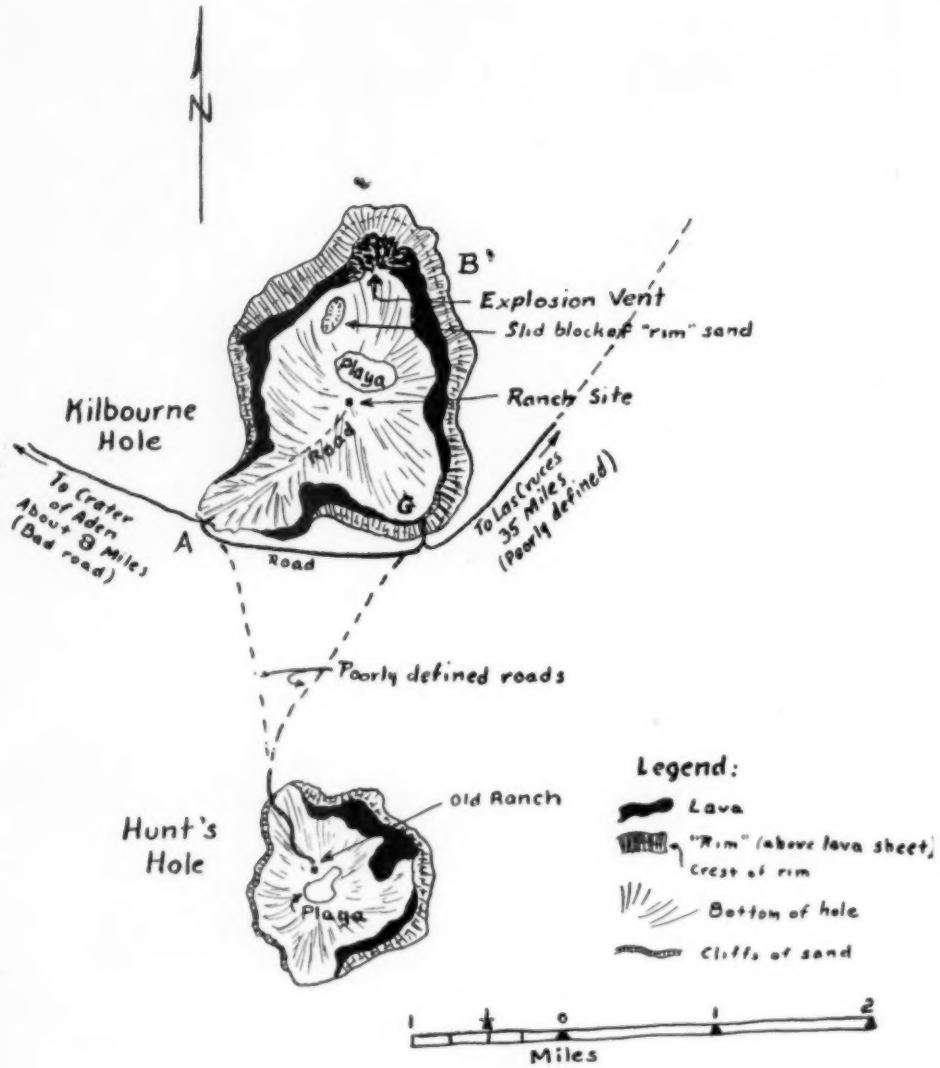

Fig. 2. KILBOURNE HOLE AND HUNT'S HOLE

had been filled to a depth of nearly one thousand feet with wind- and water-borne sands of Tertiary age. Over this flat sand area there spread, in Quaternary time, a flow of basaltic lava which thinned out as it crossed the area now occupied by the hole and reached zero thickness near what is now the hole's southwestern extremity and at one other small portion at the southeast. A portion of the same flow may have continued on as a lava "river" rather than as a sheet, to cross what is now Hunt's Hole, or the flow at Hunt's may have been quite independent. After this flow had become cold

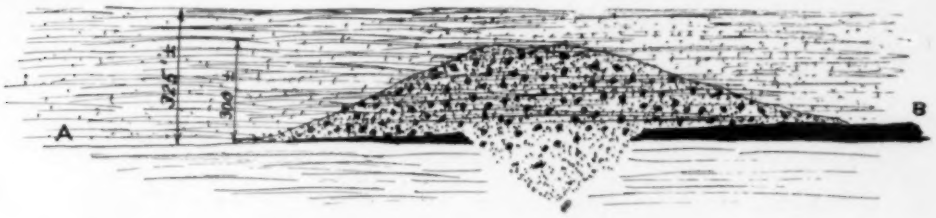

Fig. 3. AN EARLY STAGE IN THE FORMATION OF KILBOURNE HOLE

and brittle there occurred a volcanic explosion, or perhaps a succession of them, at the site of Kilbourne Hole. These fractured the lava sheet, hurling fragments of it, together with sand and miscellaneous volcanic material, from far below the earth's surface, to form a cone of these materials over three hundred feet in height. There followed a long period during which wind- and water-borne sands were again deposited over the surface of the plain, these sands penetrating the interstices of the materials of the cone and perhaps completely burying it. (Fig. 3). At the present time many of the pieces of original cone material show water wear, and the fact that many are found at a considerable distance from the cone site is ample evidence that the area has experienced extremely violent storms.

Thus far there had been no occurrence which would cause the formation of a hole, other than the small crater or craters formed by the volcanic explosions, and these craters were completely filled by the sands which buried the cone. But there now occurred a subsidence which, although it affected a large area, did not cause a lowering of the level of the entire La Mesa Plain, but rather concentrated its effect at a few relatively small areas of which Kilbourne, Hunt's and Phillips Hole are the most important. The subsidence was most pronounced at Kilbourne Hole, and here the depression was not less than three hundred feet. The center of the action was such that the entire central portion of the cone was dropped far below the level of the plain while the lower slopes of it, except at the southwest, remained undisturbed with their overcover of Recent sands. As the slump occurred (and this may have been progressive over a considerable period rather than a sudden action), the lava sheet, where not previously fractured by the explosion or explosions, was undermined and broke off into fragments which gradually moved down the sand slopes. At the small areas where the lava sheet was very thin or non-existent, the bedded sands sheared vertically to form cliffs, parts of which to date have suffered only slight modification by erosion. At the southwest, however where lava sheet protection was lacking over the greatest area, erosion has exerted its maximum effect and the cliffs have been worn away and their material swept into the hole to such an extent that the slope into the hole at this point is rather gradual (Fig. 4).

The present condition of the hole is shown in cross-section in Fig. 4. The portion at B may be taken as fairly representative in character of the major portion of the hole's periphery, while that at A is typical of only the small, severely eroded southwestern por-

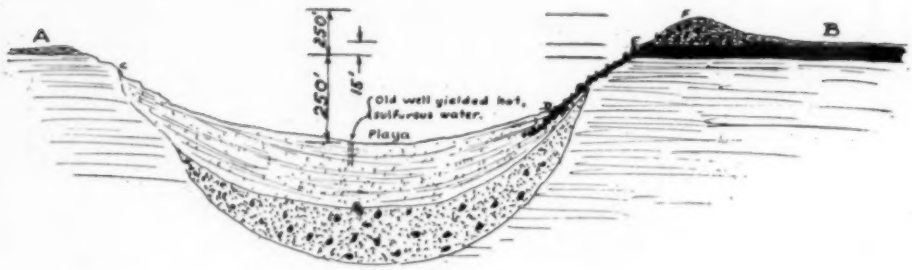

Fig. 4. A PRESENT CROSS-SECTION OF KILBOURNE HOLE

tion. Erosion has carried away most of the accumulation of water-borne Recent sands which covered the cone, except where this material has received protection by the intermingled fragments of original cone material as shown at F-B. These water-borne sands, mixed with present-day blow-sands, cover an area of several square miles in the vicinity of the holes and are identifiable by the admixture of considerable amounts of very finely divided volcanic material derived from non-local sources.

Today's visitor to Kilbourne may well drive first to point G (see map), affectionately dubbed by some as "Lookout Point", for here the rim is practically non-existent. A vehicle can be driven right to the edge of the true hole, and practically the entire hole can be satisfactorily viewed from this point. The highly venturesome, of course, can climb over the rim at any point and then clamber down over the huge blocks of rough lava to the floor. Such a trip however, although not notably dangerous except perhaps during rattlesnake season, is decidedly laborious. The writer recommends that the visitor should drive to point A, where the descent into the hole is gradual to point C, from which point the stroll assumes some of the aspects of a stroll down the slope of a beach. At the lowest point in the hole, the playa, or dry lake-bed, is easily discernible by a difference in the color of its vegetation. Toward this point moves all rainfall within the hole, carrying with it sands and other erosion debris from the slopes. Somewhat to the south of the playa is the ranch site and the remnants of a well casing. One of the two wells in the hole, probably not this one, yielded hot, sulfurous water (about 100° F) from a depth of about 100 feet. Ths fact, plus the existence of the remnant of an explosion vent toward the west from the northernmost extremity of the hole and the abundant volcanic debris in the remnant of the cone, seems adequate proof of volcanic action as a contributing factor in the hole's formation.

From point C to point D the floor is covered with blow-sand from the surrounding desert. The surface is cut by numerous small arroyos and covered with a moderate amount of typical desert growth. Near the walls specimen materials from the cone remnant may sometimes be found on the surface.

Erosion, of course, has been greatly retarded by the existing portions of the lava sheet where unbroken, and to a lesser degree by the fallen, slumped fragments which line the lower inner slopes, as from point D to point E. These large fragments or blocks bear against one another in most cases

and blow-sand and other debris partially fill the interstices so that a climb can be made with no greater danger than that which accompanies any rock-climb of moderate slope.

From E to F the climb is over the remnants of the cone of volcanic debris, and from F toward B the material is Recent waterborne sand mingled with blow-sand, all loose and shifting, making difficult walking — particularly up.

The following comprise the volcanic cone debris: basalt, olivine-augite with skins of basalt ("olivine-augite bombs"), marine limestone with poorly preserved fossils, felsite, sandstone, garnetiferous gneiss, augite, petrified wood, iddingsite (an alteration of olivine), and volcanic bombs of granite.

The granite bombs are not at all common, while olivine-augite bombs up to 10 inches in diameter are abundant. Olivine of gem quality (peridot) has been found here. Laboradorite, opal, and various zeolites, have also been reported from this locality.

HUNT'S HOLE

Hunt's Hole was formed primarily by subsidence, and undoubtedly by the same subsidence that created Kilbourne Hole. However, at this point there was no extensive sheet of lava but merely a "river" of it, approximately seventeen hundred feet in width. This was possibly an arm from the sheet that covered the Kilbourne site. This "river" was broken, undermined, and dropped by the subsidence as was the Kilbourne sheet, and where it was nonexistent the bedded Tertiary sands sheared to form vertical cliffs, considerable portions of which have resisted erosion remarkably well. The rim is low, being confined to the east and north portions, and shows no evidence of volcanic debris. Thus it may be doubted that any volcanic explosion occurred here, or if one did, its evidence has been deeply buried by blow-sand. The theory generally accepted is that the rim is entirely an accumulation of blown-sand.

The modification of the walls by erosion has been most severe at the north and south. At the north the road is easily discernible and can be safely negotiated by automobile.

PHILLIPS HOLE

Some two miles east of Hunt's Hole begins the gradual slope into Phillips Hole, the largest, shallowest, and least spectacular of the three holes. This hole appears to owe its origin entirely to the subsidence. Here there is no noticeable rim, no evidence of volcanic action, and no lava structure in evidence, although there may be and probably are buried flows in the hole or nearby. It contains a playa, but it is poorly defined.

Topographic maps of this vicinity (U. S. Geological Survey maps of Noria, Aden, Afton, Las Cruces and Mount Riley Quadrangles and vicinity) show a number of depressions, all of them probably due to the subsidence which formed the large holes. None of these is large, deep, nor worthy of prolonged study.

CAUSE OF SUBSIDENCE

A number of theories have been advanced as to the cause of subsidence: meteoric impact; solution of subterranean limestone by ground water and the removal of this limestone in solution; and volcanic subsidence. Of these, the latter is the one today held to be correct. That the district has been one of intense volcanic ac-

tivity, both prior to and subsequent to the subsidence, seems proved by the presence of numerous lava extrusions; by the volcanic debris at Kilbourne; by the fact that, as recently as 1907, hot, sulfurous water was yielded by a well in Kilbourne Hole; and by the indisputable remnant of a volcanic explosion vent at the north portion of Kilbourne Hole, a point which may well roughly indicate the center of the subsidence activity. Meteoric impacts can be ruled out because of the absence of meteoric material and non-symmetrical outlines of the holes. The underground solution theory appears quite inadequate to account for a subsidence of such large proportions.

THE CRATER OF ADEN

The Crater of Aden is only one of dozens in this immediate vicinity. It has the advantage, however, of being fairly easily accessible, being of "pocket-size" dimensions and presenting certain interesting diagnostic features. The extruded basalt may have formed the Kilbourne sheet and the Hunt's Hole "river". This possibility serves to tie the crater to the holes as does also the proximity of the holes and the crater to one another.

The crater is about eight miles (as the crow flies) northwest of Kilbourne Hole, but the desert road which connects them is not recommended. The best route to follow is to retrace the Las Cruces — Kilbourne Hole route to the railroad section point known as Afton. Without re-crossing the tracks, continue from here northwesterly along the west side of the railroad to Kenzin, at which point a reasonably well defined desert road swings westward and practically circles the crater, finally approaching it from the west. As this road makes its swing toward the west slope of the cone, a dim branch swings slightly further to the south and then (over very rough lava beds) runs right to the crater's rim at its southeast portion. This latter approach involves some time wear; the westerly approach involves a rather difficult half-mile hike with considerable wear and tear on shoe leather, but is perhaps the more spectacular and thrilling of the two.

Study of the crater indicates that it resulted not from a single eruption, but from several. The time lapse between them may have been, however, so brief that they might perhaps better be considered successive phases of a single activity. It simplifies the explanation, however, to speak of three eruptions of which the second was probably a series of similar recurrences.

The first eruption may have been briefly violent but quickly changed to a quiet effusion of lava of low viscosity which spread in a thin sheet over a large area (Fig. 5). As the discharge rate decreased, the cooling rate did likewise, and the lava, instead of spreading over large areas, showed a tendency to stiffen and harden at the edge of the discharge orifice, thus forming the original low rim which is the present outermost and most nearly complete of several fairly well defined, nonconcentric rings of ridged lava. This original rim cracked at many points as it cooled, and at the same time the main underground mass of molten lava shrunk and receeded to a point probably several hundred feet below the level of the plain.

In the second eruption, the lava failed to break through the tough, newly-formed material at the base of the original vent, but found a

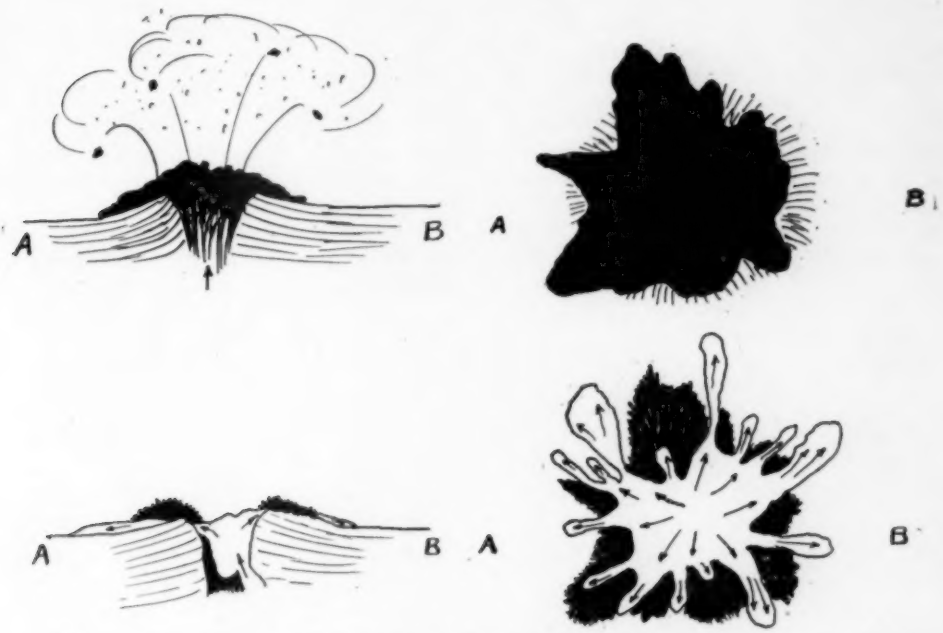

Fig. 5. (Above) The Crater of Aden. The first eruption of basalt. Left, cross section; right, map plan.

Fig. 6. (Below) The Crater of Aden. The second eruption, in which new basalt (white) is spreading through cracks in the original (black) cone. Left, cross section; right, map plan.

crack or other point of weakness in the side-wall lining. Through this break it welled, filling the original crater to such level that it finally spilled through cracks in the original rim (Fig. 6). The cooling and shrinkage after this eruption left a new low rim within the first one. The space between them remained filled with nearly flat second eruption lava at the level of the base of the cracks in the original rim. Again shrinkage of the subterranean mass of molten lava lowered the level within the crater, perhaps to a point below the bottom level of the original crater. This second crater (or craters, considering this the first of a succession of lesser actions of similar type) was never filled with lava by subsequent activity. Fallen debris from its walls and blow-sand have partially filled it, obscuring its true bottom.

The third eruption apparently did not involve any flow of lava but was merely a violent venting of an accumulation of incandescent gases. As in the preceeding instances, this mass of material failed to melt or force its way through the new core material in the crater, but found a point of weakness in and toward the outer slope of the original rim (Fig. 7). It melted and scoured the walls of the crack as it rushed upward, enlarging its path and converting it from a true crack to a tube structure of varying cross-section — a fumarole.

Thus we have today a condition represented in cross-section by Fig. 8. Moving in a generally west-east direction from point A we

Fig. 7. The Crater of Aden. Third eruption and formation of the fumerole.

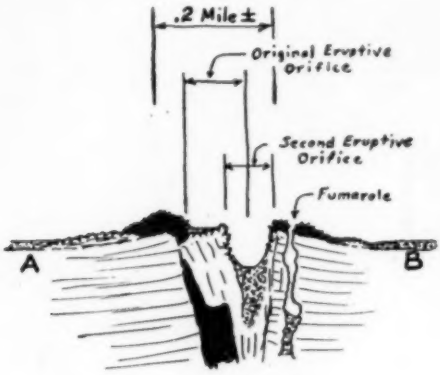

Fig. 8. The Crater of Aden. A present cross-section.

have a gradual climb up the slope of the original flow, on which can be observed numerous "trains" and "rivers" where the second flow poured out through the cracks in the original rim. A steeper climb is made over the ragged material of the original rim (or a less arduous meander through one of the cracks therein) onto the bed of second-eruption lava which practically filled the original crater. From the second rim, the more intrepid explorer can descend to the bottom of the second crater, exploring en route a multitude of small caves. The fumerole opening has been enlarged by mechanical means to about eight feet in diameter and is partially covered by a wooden grating above which rises a wooden head-frame. Other than a heavy wire cable dangling into the fumarole from this head-frame, there is no provision for a voluntary descent into the fumarole and this existing equipment is quite inadequate for the purpose. An involuntary descent is to be avoided at all costs.

The history of this crater doubtless closely parallels that of many others. There are, however, two features which afford it more than average interest, and both of these are chiefly concerned with the fumarole. Many are the local "yarns" telling of persons having disappeared in this vicinity, presumably having fallen or purposely jumped into this fumarole and having never been recovered from the debris at its bottom. The possibility of a number of such occurrences within or prior to recorded history is undeniable although proofs are lacking, but one animal which became trapped in the fumarole and one man who fell into it and was rather amazingly rescued alive, have given it a measure of prominence.

In the course of centuries there accumulated at the base of the fumarole a considerable amount of bat guano. The climate here being very dry, and the fumarole opening being too small to admit appreciable quantities of the infrequent rains and less frequent downpours, this guano was completely desiccated and is of the finest powder-like texture. It was in this guano that a group of El Pasoans discovered the remains of a prehistoric ground sloth, **Nothrotherium shastense** which had fallen into the fumarole or may have wandered

into it by way of the crack from which it was formed, only to be entrapped by the falling of debris. Although no such crack has been discovered on the surface, that one exists, filled with loose debris and thus not "airtight", may be an explanation of otherwise unexplained air currents moving into or out of the mouth of the fumarole. These sloth remains proved to be no mere skeleton, but rather a well-preserved carcass retaining patches of hide and hair and containing a quantity of identifiable partially digested food. It was recovered by a party of scientists from Yale University, and the story of its discovery, removal, and subsequent study has been told in a most interesting book, **A Remarkable Ground Sloth**, by Professor R. S. Lull.

A few years ago a party was organized to salvage the guano from the fumarole. In preparation for this work, the orifice was enlarged and various passages straightened. It is reported that the removal of the guano was quite complete, but to the writer's knowledge there was no discovery of other animal remains during the proceedings.

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Coal Resources of Michigan Appraised

WASHINGTON, Nov. 16 — Measured coal reserves in Michigan totaling 125 million tons have recently been delineated and appraised by the U. S. Geological Survey with the cooperation of the Michigan Geological Survey Division, and the Department of Geology, University of Michigan.

This study was undertaken as a part of the U. S. Geological Survey's program to re-estimate the coal reserves of the United States. The work in Michigan was carried out early in the program to furnish data on the coal in Michigan that is available for future development, and to aid in further exploration for coal in the State.

During the course of the Geological Survey's study, more than 2,500 logs of coal test wells, many hundreds of logs of oil wells, mine maps, and all records of past and present mining and exploration in the files of the U. S. Geological Survey, the Michigan Geological Survey Division, the Department of Geology, Univ. of Michigan and cooperating mining companies were correlated and examined. Maps showing all known coal-bearing areas, and all mined out areas, as well as areas favorable and unfavorable for exploration, were prepared.

A preliminary appraisal of the results of this comprehensive study showed 15 million tons of coal in beds more than 42 inches thick; 81 million in beds 28 to 42 inches thick; and 29 million in beds 14 to 28 inches thick. These reserves are reserves that have been accurately measured, or proved, by drilling and mining.

A detailed report on the results of this study by George V. Cohee and others is now in preparation.

Tables showing the provisional appraisals of measured reserves in each township, by beds in different-thickness and depth-of-overburden categories, have been completed in preliminary form, and copies are now available for use by interested persons, particularly those who may have additional information on Michigan coal reserves that should be incorporated in the final report. Copies of these tables, titled "Measured coal reserves in Michigan by townships and counties," may be obtained without cost upon application to the Director, U. S. Geological Survey, Washington 25, D. C.

Rare-Earth Deposit Found In California

WASHINGTON, Nov. 18 — An important deposit of rare-earth minerals in an extremely unusual geological formation has been uncovered in southeastern California, it was announced today by Dr. W. E. Wrather, Director of the United States Geological Survey.

The deposit lies near Mountain Pass Service Station on Route 91 in San Bernardino County, 53 miles southwest of Las Vegas, and 33 miles northeast of Baker, California. The discovery was made in April, 1949 by two of the owners, Clarence Watkins and Herbert S. Woodward of Goodsprings, Nevada.

The unusual nature of the deposit was recognized when the minerals were found to be radioactive by test with the Geiger counter. A preliminary geologic examination has been made by D. Foster Hewett of the U. S. Geological Suruvey who states that within an area of about 600 by 1,500 feet underlain by Archean rocks, there are at least five veins, three of which contain considerable bastnasite, a fluo-carbonate of cerium and lanthanum, with thorium and uranium. The uranium and thorium content, however, appears to be too small to make the deposit of commercial interest for the recovery of these two elements.

In a shallow shaft, the largest vein is about 15 feet wide and it contains between 20 and 30 percent bastnasite. Other rare-earth minerals are present. Accessory minerals are limonite, hematite, barite, fluorite, siderite, quartz, and a little galena. Bastnasite is commonly found in small quantities in some pegmatites; the deposit near Mountain Pass is several lodes in which the most abundant mineral is bastnasite.

Thus far, only the assessment work necessary to hold the claims has been done. A Geological Survey party has begun a program of geologic mapping and geophysical work in order to determine the number and continuity of the lodes. A program of laboratory work has been started to determine the number, identity and abundance of the several minerals that make up the lodes.

"There can be no doubt", says Mr. Hewett, "that the lodes of the area are a potential commercial source of cerium and lanthanum, the present supply of which is derived from monazite, a mineral largely imported".

Cover Photo

This month's cover photo is of a limestone pedestal rock near Eureka Springs, Arkansas. These pedestal or "mushroom" rocks are formed by abrasion or differential weathering, the weaker rock being etched away. Photo by W. D. Keller.

FROZEN GROUND STUDIES – PART I

Microrelief Forms In the Tundras In Priamur'e

SOCHAVA, V. B., Tundrovye formy mikrorel'efa v Priarmur'e' (1): Akademia Nauk SSSR, Priroda, no. 5-6, pp. 107-109, 1944.

Condensed and emended by I. V. POIRE. — U. S. Geological Survey, 1949.

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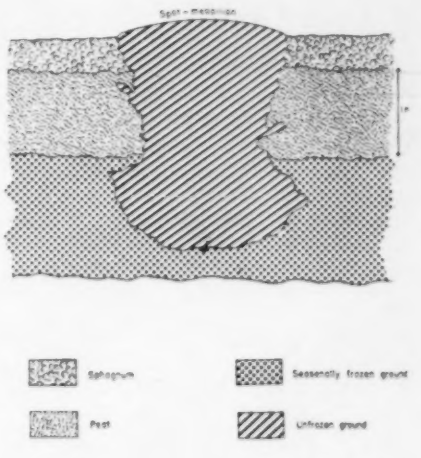
Cemetery hummocks (2), **pingos**, bowl-like hollows, and **spot-medallions** are **thermogenetic** forms of mesorelief and microrelief. Changes in them occur very quickly. Cemetery hummocks were found in some kinds of bogs and in some regions of swampy mineralized soils overgrown with larch wood.

The spot-medallions are very common in the basin of the Amur River. They are similar to those of the Karskaia tundra, of the Yenisey forest tundra and of the basin of the Anadyr' River. They are similar to the modified forms of these spots which occur in the southern parts of the tundra where there is a swampy Sphagnum cover underlain by a thick peat layer. These spots have not been found in the north Yakutian area. They are sparse in the Anadyr' Basin, but very abundant in the area adjacent to the Penzhinskaya Guba (Gulf of Penzhina). Spots of this kind are very common on the foothills of the North Ural Mountains.

The spots are areas of exposed sticky, loamy ground. As the cross-section (Fig. 1) shows, they are columns of loamy ground in a layer of peat, whose thickness is more than 1 meter; the peat is



I. V. Poire

Fig. 1. Diagrammatic cross-section of a spot-medallion.

overlain by a Sphagnum sod. In the Anadyr' region such spots occur on the clayey lacustrine formations, on the sedge hummocky tundra overgrown with green moss. The origin of these spots is the same as that of cemetery hummocks. The impetus for their formation is the stress in the ground resulting from the uneven freezing of the **active layer** and its adfreezing to the **merzlota.** The imperative condition for the formation of cemetery hammocks is a sufficient thickness of the active layer. Where the thickness of the active layer is small, as in bogs, in valleys, and in lowlands, the spots (medallions) occur. They actually

(1) Priamur'e is the country adjacent to the Amur River in E. Siberia. It means "near Amur".

(2) For explanation of terms see Glossary at end.

form right before your eyes; old cemetery hummocks and old spots decrease at the same time new ones are forming.

It seems as if the process of freezing of the active layer is irregular or wavelike; freezing action upon the relief also is wavelike. This means that the thermogenetic relief features are formed in places where they were absent before, and the old hummocks and spots become denuded and disappear.

The author has explained, in an earlier paper, (3) the formation of spotted tundra as a result of the unequal freezing of the active layer due to the change in its physical properties, and to the degradation of the peat. This degradation has been considered the inevitable result of the development of vegetation and soil under conditions of imperfect growth of swamps and accumulations of peat. Cemetery hummocks are lacking where moss and hummocky bogs are supersaturated with water and where the peat layer is increasing (aggrading). Swelling occurs where these bogs are decreasing and where there is a partial degradation of the peat layer, or where a delay in its growth takes place. As a consequence of the degradation of the peat layer, large pores or cracks in the form of channels of small width appear. These channels are filled with fluid ground ("subsoil") supersaturated with water. An increase in the volume of the subsoil takes place during freezing. This earth mass supersaturated with water rises towards the surface in successive years and grows wider on all sides owing to the inflow of new portions of the fluid mud. This process of spot or medallion formation does not last long. The hydrostatic pressure in this case is greater than in other types of spotted tundra, because of the supersaturation of the ground. The profile of such a medallion has the shape of a funnel or of an irregular rhomb; there are, however, spotted tundras of other origins. (4) The process of the upheaval of ground ceases after most of the ground has been exposed and has formed a medallion. The surface of the mud dries and the ground beneath the spot becomes porous. A porous mass can absorb a large quantity of water and consequently the volume of the spot does not increase very much when the freezing starts.

Merzlota was not found under the medallions in the Priamur'e, but thermal conditions of the ground there are similar to those mentioned above. In this process of spot formation in other regions merzlota acts as a water-impermeable layer. In Priamur'e other kinds of water-impermeable ground are responsible for spot formation.

(3) Sochava, V. B., O piatnistyh tundrah Anadryskogo Kraia [The spotted tundras of the Anadyr' region]: Akademia Nauk SSSR, Trudy Poliarnoi Komisssii, vol. 2, 1930.

GLOSSARY

Active layer, the upper part of the earth crust, in the regions with merzlota, that is subject to seasonal thawing. In other words, the active layer is the upper part of the merzlota that is subjected to seasonal thawing. The active layer is not synonymous with the seasonally frozen layer. Its thickness and the time required for its thawing and freezing is controlled by the zero curtain. (M. I. Sumgin).

Cemetery hummocks, hummocks or mounds that are formed in marshes and

(4) Sochava does not explain their origin.

bogs in regions with merzlota. The formation of the hummocks is due to the action of freezing diluted ground under hydrostatic pressure. This pressure occurs in places where the freezing of the active layer is not uniform. The dimensions of hummocks are: relative height above the bottom of the adjacent hollow, 0.2 to 1.0 meter; the diameter of the base, 1.0 to 2.5 meters. A swamp covered with this kind of hummocks resembles a Russian cemetery.

Degradation, gradual decreasing, wearing away.

Merzlota, as used by most Russian scientists, has a more restricted meaning than the American term "permafrost". Merzlota is a body (or its physical state) of sedimentary, metamorphic or igneous deposits, that has negative temperatures (below O°C.) lasting more than two years, and that contains water and minerals whose freezing temperature is below O°C., predominantly in solid phase.

Permafrost includes not only merzlota, but also deposits in which the water and some minerals are not in solid phase, or in which water is absent.

Naled', plural naledi, frozen sheets of water poured out above ice of rivers or lakes, or above the bottom of a valley, or between the beds of deposits. The formation of a naled' is due to the hydrostatic pressure of a dammed river or of ground water.

Permafrost, as defined by Muller, is a thickness of soil or other surficial deposits or even of bedrock, at a varied depth beneath the surface of the earth, in which a temperature below freezing has existed continuously for a long time (from two years to tens of thousands of years). This definition is practically M. I. Sumgin's.

Pingos or hydrolaccoliths, large hummocks whose formation lasts many years and is due to the hydrostatic pressure of ground-water from below the merzlota. Pingos are often related to the naledi.

Spot-medallions, bare spots of ground in swamps or bogs. They are somewhat elevated above the surface of the swamp or bog and are related to hummocks. These spot-medallions are either disappearing hummocks or occur where the thickness of the active layer is not sufficient for the formation of hummocks.

Thermogenetic, produced by heat (or temperature changes).

Zero curtain, is a layer of soil or ground, whose temperature is O°C., and which hampers the heat exchange in the soil. The zero curtain can move; it can occur immediately below the earth's surface and move downwards; this movement depends on the moisture content in the ground. The zero curtain is absent in dry soil or ground where the latent heat of freezing or thawing is absent.

Grim To Head Clay Mineral Section of Soil Science Congress

URBANA, Ill., Nov. 28 — Dr. Ralph E. Grim, of the Illinois State Geological Survey, has accepted the invitation of Professor C. H. Edelman, of Holland, to serve as vice-chairman of the Section of Clay Minerals for the Fourth International Congress of Soil Science. Professor Edelman is Chairman of the Organizing Committee of the Congress, which will be held in Amsterdam, Holland, in July, 1950.

Dr. Grim is Head of the Survey's Division of Clay Resources and Clay Mineral Technology and Research Professor in the Department of Geology, University of Illinois. Dr. Grim is well-known internationally for his research on clay minerals and on the use of clay minerals in ceramics, soil mechanics, the petroleum industry and other industries.

Earth Science Abstracts

[Selected articles on the earth sciences, appearing in current scientific publications, are abstracted here for the convenience of our readers.]

PALEONTOLOGY

POLLEN ANALYSIS AND THE AGE OF PROBOSCIDIAN BONES NEAR SILVERTON, OREGON. Henry P. Hansen and E. L. Packard. **Ecology.** Vol. 30, No. 4 (Oct. 1949), pp. 461-468. Mammoth bones discovered in 1946 represent the richest find of proboscidian bones yet reported from this area. The author arrived at an age of 10,000 years or probably a little less for these bones by dating them by (1) the thickness of the overlying sediments and their rate of deposition; (2) the typological succession of the sediments and the stratigraphic postion of the pumice; and (3) the stratigraphic position of the bones in relation to the xerothermic interval.

❖

THE LAST SURGE OF THE NAUTILOID CEPHALOPODS. A. K. Miller. **Evolution.** Vol. 3, No. 3 (Sept. 1949), pp. 231-238. Appearing late in the Cambrian, the nautiloids evolved rapidly during the Ordivician, climaxing in the Middle Silurian. The ammonoids evolved from them in the Lower Devonian and became extinct in the Upper Cretaceous, soon followed by the eruptive evolution of the nautiloids. The causes of the disappearance of the ammonoids and the dwindling of the nautiloids are unknown.

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PALEOGEOLOGY OF THE PANHANDLE OF TEXAS. Robert Roth. **Geol. Soc. America Bull.,** Vol. 60, No. 10 (Oct. 1949), pp. 1671-1688. The sedimentary sequence and facies changes in the subsurface are shown by cross-sections. The stratigraphic column is divided into 13 geologic subdivisions, the areal distribution of each being shown by a paleogeologic map.

SUBMARINE GEOLOGY

NORTH ATLANTIC HYDROGRAPHY AND THE MID-ATLANTIC RIDGE. Ivan Tolstoy and Maurice Ewing. **Geol. Soc. America Bull.,** Vol 60, No. 10 (Oct. 1949), pp. 1527-1540. Two very distinct types of topography characterize the Mid-Atlantic Ridge: (1) The Terraced Zone, a succession of horizontal flat stretches from 2500 to 1600 fathoms, found along both Ridge flanks at the same depths. They recur off the northwest African coast. (2) The Main Range, a succession of parallel mountain ridges trending NE.-SW., above 1600 fathoms. Not much can be concluded about the origin of the Ridge The deeper sections of the North Atlantic Basin between Bermuda and the Azores are occupied by a conspicuously flat plain at 2900 fathoms.

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TERRESTRIAL TOPOGRAPHY OF SUBMARINE CANYONS REVEALED BY DIVING. Francis P. Shepard. **Geol. Soc. America Bull.,** Vol. 60, No. 10 (Oct. 1949), pp. 1597-1612. The Scripps and La Jolla canyons, north of San Diego, Calif., were investigated by diving. Vertical and overhanging rock walls, narrow tributaries, and sediment-covered canyon floors were found. Evidence shows that the topography could not be due to moderate lowering of sea level, and that the canyons were excavated by streams, the heads being filled and the fill removed from time to time by mud flows. No strong currents were found.

PETROLOGY

HAWAIIAN PETROGRAPHIC PROVINCE. Gordon A. Macdonald. **Geol. Soc. America Bull.,** Vol. 60, No. 10 (Oct 1949), pp. 1541-1596. Olivine basalt is the parent magna of the Hawaiian Islands. It is concluded that other rock types were derived through crystal differentiation. Comparison of these and rocks from other Pacific islands suggest essential uniformity of parent magma and petrogenic processes throughout the Pacific Basin. Rock types are described, as well as the distribution and structural relationships of the rocks and their petrogenesis.

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WISSAHICKON SCHIST AT PHILADELPHIA, PENNSYLVANIA. Judith Weiss. **Geol. Soc. America Bull.,** Vol. 60, No. 10 (Oct. 1949), pp. 1689-1726. The structure petrology, and metamorphic zones of this type area are recorded and correlated. The schist was originally a sediment composed of sandy, shaly, and arkosic layers of varying thickness and composition, which has been completely recrystallized and highly deformed during regional metamorphism. The rock structure is believed to be that of an abnormal synclinorium produced by compression.

URANIUM RESOURCES AND RADIOACTIVITY

[The following abstracts are reprinted in part from **Nuclear Science Abstracts,** Vol. 3, Nos. 5-10 (Sept. 15 - Nov. 30, 1949), by permission of the U. S. Atomic Energy Commission Technical Information Branch, Oak Ridge, Tenn.]

ON THE DISTRIBUTION OF RADIOACTIVE MINERALS IN A GRANITE. Renè Coppens. **Compt. Rend.,** Vol. 228, pp. 1218-1220 (Apr. 4, 1949) (in French). The study of the radioactivity of a Brittany granite has resulted in a complete determination of the radioactivity present. The ratio of the concentration of thorium to that of uranium was determined as approximately 2.8 using the relationship between the concentration of these elements and the number of beta particles in a particular range which were detected. The lack of uniformity in the distribution of the radioactivity within the crystal is noted.

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RADIOACTIVITY OF OCEAN SEDIMENTS. VII. Rate of deposition of deep-sea sediments. Wm. D. Urry. **Jour. of Marine Research,** Vol. 7 (1948), pp. 618-634. The rate of sedimentation can be determined from the radium content of the sediments, since variations in radium content occurred during the establishment of radioactive equilibrium in deep-sea deposits. Rates of deposition as a function of time (for the past half-million years) are reported for red clay, globigerina ooze, foraminiferal marl, glacial marine deposits, and calcareous blue mud.

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THE RADIOACTIVITY OF SEDIMENTS. E. N. Tiratsoo. **Petroleum,** Vol. 12, March 1949, pp. 61-65. The gamma-ray well-logging technique has established itself as a standard method of oil field investigation. This article describes a laboratory method of estimating the radioactivity of rock samples. Previous laboratory determinations of radioactivity needed much larger amounts of rock. (See also Earth Science Abstracts, Sept. 1949).

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THORIUM IN WEAKLY RADIOACTIVE SUBSTANCES AND ROCKS. Arlette Hee. **Ann. Geophys. Strasbourg Universite, Institut de Phys. du Globe,** Vol. 4, Pt. 3 (1948), pp. 30-59. The role of thorium in weakly radioactive substances and rocks, and the variations, if any, produced by thorium in their radiation has been investigated. The

rocks studied included travertines and arkoses. Results suggested that radioactive prospecting would be aided by a knowledge of the permeability of rocks to radioactive gases.

❖

WHERE ARE URANIUM AND THORIUM STORED IN THE ARCHEAN BASEMENT? Robert Schwinner. **Geof. Pura e Appl.,** Vol. 14, Nos. 1-2 (Jan.-March 1949), pp. 10-36 (In German). The author advances a theory which makes it possible to predict where prospecting for new deposits of uranium and thorium should prove successful. According to this theory, such deposits occur chiefly where the equatorial and the meridional branches of the oldest primitive rocks systems cross one another. An outline of the earth's Archean basement is included.

Earth's Shape Pictured From Gravity Differences

MADISON, Wis., Nov. 2 (Science Service) — Two scientists at the University of Wisconsin are busy with computations which they hope ultimately will give the exact shape of the earth.

Prof. George Prior Woollard, University geophysicist, and N. C. Harding, a graduate student, are correlating gravity measurements taken at different points on the globe by Mr. Harding and other graduate students during the summer.

Since the earth is of an irregular shape, being pumpkin - shaped rather than perfectly spherical, the pull of gravity varies by minute but measurable differences. From measurements of these differences recorded from many points on the earth's surface, scientists will be able to make an exact model of the earth showing all its bumps and wrinkles.

However, it will take many thousands of such measurements and long and painstaking correlation of them before this point is reached. Prof. Woollard, who instituted the project in 1940, has traveled all over the northern hemisphere taking measurements. Mr. Harding took readings at some 400 different places throughout South America and Alaska on his expedition this summer.

Although the theoretical basis for relating earth size to varying gravitation has been know for a hundred years, it is only recently that the development of a portable, accurate gravimeter, the gravity measuring instrument, made extensive field work possible.

Changes In Mexican Mining-Tax Structure Listed

WASHINGTON, Nov. 30 — Recent changes in the mining-tax structure of Mexico are summarized for the benefit of American interests importing minerals from that country in a publication released today by the Bureau of Mines. The changes, the report says, were made partly because of the depreciation of the Peso and partly to encourage small, marginal operators.

A free copy of Special Supplement No. 31 to Volume 28, No. 5, Mineral Trade Notes, "Addenda to Mining Taxes in Mexico, prepared by J. Kellogg Burnham, general economic assistant, under the supervision of Horace H. Braun, economic analyst, Industrial Engineering Section, American Embassy, Mexico City, Mexico, may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburg 13, Pa.

Research In Geophysics and Terrestrial Magnetism at the Carnegie Institution *

The Geophysical Laboratory

The investigations at the Geophysical Laboratory are now focused sharply on the formation and properties of rock-forming minerals with and without the presence of mineralizers, such as water, for the general purpose of understanding the complex processes by which the earth was formed. Of the many thousands of minerals that are known to the geologist, only a dozen or so are of any great consequence in the genesis of rocks; and in this limited class two, quartz and feldspar, occupy a pre-eminent position. The Laboratory, which in its earliest days logically gave primary attention to these particular minerals, has now with vastly improved apparatus and techniques turned again to the study of some of their characteristics.

Quartz has the interesting property of changing at 573° C. from one crystalline form to another. Recent measurements have shown that the transformation temperature is not a fixed point as it was formerly believed to be, but may vary by nearly 2°, which even at moderately high temperatures is readily measurable with modern precision thermometric devices. It appears that the variation in the behavior of different quartz specimens is related to the conditions under which the quartz originally crystallized; and, therefore, that a further correlation of inversion temperature with geologic environment will furnish a valuable clue to the temperature of formation of any given sample of quartz.

Related information has been provided by the measurement on feldspars, which consist mainly of three different types depending on the predominance of lime, soda, or potash. In the work on hydrothermal synthesis, it has been discovered that the sodic form, albite, may exist in either of two different modifications depending on the temperature of formation. Natural albite is usually of the low-temperature form, whereas that produced synthetically hitherto has always been of the high-temperature variety. Other peculiarities in feldspars are understandable through the discovery that the solid solution existing at elevated temperatures sometimes unmix at low temperatures, the extent of unmixing depending on the temperature. An X-ray technique permits ready determination of the composition of many feldspars. Further work is needed, yet already the new method of study appears to make it possible to determine the temperature of formation of feldspar when any two feldspars are found together in a single place. Thus there is now a strong likelihood that both quartz and feldspar will provide realible geologic thermometers by which the temperature of past earth processes may be inferred.

*From the annual report of Dr. Vannevar Bush, as President of the Carnegie Institution of Washington, for the year ending June 30, 1949. The annual meeting of the Board of Trustees was held in Washington, D. C., on December 9, 1949.

The Department of Terrestrial Magnetism

The Department of Terrestrial Magnetism has brought to successful conclusion a series of experiments focused on one of the few direct and clear-cut puzzles in geophysics, tht of the maintenance of the earth's electric charge. Since the vayages of the **Carnegie** during World War I, it has been known that the earth always carries a rather large negative electric charge, shown by the electric field near the surface in fair-weather areas over land and sea. This charge is maintained despite a measured total air-earth current, summed up for all fair-weather areas, of 1500 amperes, flowing in the direction which tends to dissipate the charge. The suggestion was made in England more than twenty years ago that thunderstorms might supply the necessary reverse current, but it has never been possible to prove or reject this idea because of the tremendous variability of the air-earth currents observed beneath thunderstorms.

When the staff of the Department of Terrestrial Magnetism resurveyed the status of knowledge of "the electric and magnetic condition of the earth and its atmosphere" in 1946, three conspicuous puzzles were selected as basic problems of primary significance, disregarding the point that each of these seemed at the time largely inaccessible to direct investigation: (a) What are the direct and indirect causes, inside the earth, of the main part of the earth's magnetic field? (b) What mechanism supports and maintains the earth's net electric charge? (c) What and where are the origins of cosmic-ray particles? One of these underlying problems, that of the earth's electric charge, is now resolved with reasonable clarity, and important information on a second one, the origin of cosmic rays, was unexpectedly provided by the Department's observations, reported two years ago, of sudden cosmic-ray increases accompanying solar flares and radio fade-outs. Since, in general, direct contributions toward the solution of fundamental puzzles, even when the basic questions are recognized and conspicuous, are the exception and not the rule in scientific work, these unexpected successes further encourage a policy which deliberately focuses attention on the formulation and attacking of basic problems even when they seem inaccessible.

For years discussion has been aroused by the theory that the continents of the earth as we know them may have drifted from some earlier configuration to their present pattern, and, indeed, that they may still be imperceptibly moving. Studies of the direction of magnetization of rocks laid down in early epochs now show some promise of yielding evidence bearing on this question. There are rocks in the Blue Ridge Mountains near Washington which are magnetized as though they had originally been laid down in South Africa. Possible instability of magnetic north and possible large-scale local magnetic disturbances from electric current systems inside the molten earth will have to be reckoned with in any effort to explain why this is so. That effort certainly will also have to consider the hypothesis that the crust has moved with hespect to geographic north since the ancient epoch when these rocks were laid down.

Studies by the Department on prehistoric changes in the direction of the earth's magnetic field —the compass direction—hitherto made at specific locations in New England and under the Pacific Ocean, by determinations of the

residual magnetization of samples of clay and unconsolidated sediments, were extended this year back into geological periods earlier than two hundred million years ago. This was done by making observations on a long series of sedimentary rocks. The unfolding of this story of ancient magnetism in recent years at the Department has been dramatic as it progressed, first in painstaking fashion back through twenty thousand years of the last glacial period, then leaping back one million years by measurements on ocean cores. This encouraged an expedition to the west, carrying the record back through eighty million years by measurements on rock samples collected in the region extending from South Dakota through many parts of the Rocky Mountains to the Cascades.

This year the story rolls time back more than two hundred million years to a period prior to the folding of the Appalachian Mountains, by studies of sandstones found in Maryland and Virginia which were laid down more than three hundred and fifty million years ago. Studies of the direction of residual magnetization of rock samples taken from different portions of a fold show that the magnetic vectors in the different samples would be parallel if the folded rock were returned to its original flat condition. These "reconstructed compass directions" are found parallel to each other for locations 50 miles apart amid the folded rocks, although the vector found differs violently from the present compass direction. The complex magnetic pattern found in the folded rocks could not be produced by any possible ancient system of localized earth currents, but the parallel vectors in the original flat rocks might well be a record of the compass direction when the rocks were laid down in that ancient Silurian epoch, just as the varved clays of New England show the compass direction of twelve thousand years ago, and clay suspensions redeposited in the laboratory show the 1949 compass direction in Washington.

Any conclusions on the problems suggested by the findings thus far made in this study will be unjustified until they are supported by long and comprehensive studies of similar and related rocks from widely distributed sites. In support of the initial series of exploratory observations required for this purpose, the Carnegie Corporation has made a special grant to the Institution, and field studies have been started at a series of locations from Alabama to Maine.

It was hardly anticipated that studies of the prehistory of the earth's magnetic field, in search of causes internal to the earth which could produce that field, would lead to these startling questions relating to motions in the earth during early Palezoic time. It is reasonable to expect that a highly complex but interesting picture eventually will be found in the magnetic pattern of these ancient rocks. It is reasonable also to expect this magnetic pattern in part to be related to "secular variation foci" which we believe are caused today by electric currents deep inside the earth. These special effects may have been much greater in those ancient periods when the earth was younger and presumably more fluid. In any event it will be interesting to follow the further development of these studies of such a delicate and intangible phenomenon as the compass direction and its variations, through one age after another during the long sweep of geologic time.

New Books

All books listed here are deposited in the Library of The Earth Science Institute and may be borrowed by the members. Books marked with an asterisk may be purchased through The Earth Science Publishing Co., Revere, Mass.

*MINERALS AND MINERAL DEPOSITS.

W. R. Jones and David Williams. 1949 248 pp., 56 figs.; $2.00. (Oxford University Press, London). This pocket-size (4¼ x 6½") volume contains a wealth of information on minerals, rocks, mineral deposits, mineral exploration, and mineral resources. Particularly outstanding are the chapters on the internal structure of minerals, economic mineral deposits, and the search for mineral deposits. Although such terms as wolfram, tinstone and zinc blende (wolframite, cassiterite, and sphalerite) might appear strange to the American reader, the authors usually mention the American names in the text and glossary when they differ from the English terms.

*CLIMATE THROUGH THE AGES.

C. E. P. Brooks. 2nd Edition. 1949. 396 pp., 39 figs.; $4.50. (McGraw-Hill Book Co., New York). In this study of the climatic factors and their variations, the author presents a comprehensive study of the numerous theories which have been brought forth to account for climatic changes. An extended discussion on the theory of continental drift is of particular interest, as is the section on climates of the geologic past. Among the things added to this edition are Sir George Simpson's theory of variations of solar radiation and F. E. Zeuner's work on the astronomical causes of the succession of glacial and interglacial periods.

*FLUORESCENT GEMS AND MINERALS.

Jack DeMent. 1949. 68 pp., 1 fig.; $1.50. (Mineralogist Publishing Co., Portland, Oregon). In this interesting book, the author lists all of the known fluorescent, ultraluminescent, infraluminescent, phosphorescent, and thermoluminescent, minerals. Ultraviolet and X-ray sources are described. The fluorescent gems and minerals are listed separately. The two lists are not cross-indexed with one another and there is no index to the book. A number of typographical errors detract from the scientific value of the book, which is nevertheless an essential publication for the mineral collector's library.

DIRECTORY OF GEOLOGY DEPARTMENTS OF EDUCATIONAL INSTITUTIONS IN THE UNITED STATES AND CANADA.

Dorothy Johnson, Shepard W. Lowman, and John T. Rouse. 1949. 136 pp.; $1.50. (American Association of Petroleum Geologists, P. O. Box 979, Tulsa 1, Okla.) This directory gives information on the staff, courses, course credits, and major requirements of 150 geology departments in the United States and 10 in Canada. This list includes only schools that are known to offer a sufficient number of courses in geology to permit a student to major in this field. It is based on the academic year beginning in September, 1948. (Attention might also be called to the Association's Directory of Geological Material in North America by J. V. Howell and A. I. Levorsen. 1946. 112 pp., 75¢. This publications lists sources of maps, well information, aerial photographs, geologic publications, books, reports, specialized services, etc.).

CERAMIC UTILIZATION OF NORTHERN KANSAS PLEISTOCENE LOESSES AND FOSSIL SOILS.

John C. Frye, Norman Plummer, Russel T. Runnels, and William B. Hladik. 1949.

76 pp., 3 pls., 10 figs.: $0.10. (Bulletin 82, Part 3, State Geological Survey of Kansas, Lawrence, Kansas). These wind-blown silt deposits constitute the most widespread ceramic raw material in Kansas. They are used as raw material for brick, tile, and both light and heavy ceramic aggregates.

GEOLOGY AND GROUND-WATER RESOURCES OF PAWNEE AND EDWARDS COUNTIES, KANSAS.

Thad G. McLaughlin. 1949. 190 pp., 9 pls., 12 figs.: $0.25. (Bulletin 80, State Geological Survey of Kansas, Lawrence, Kansas). Outcrops range in age from Cretaceous to Recent. The principal valleys and the adjacent areas are underlain by alluvium and terrace deposits, and the large area lying south of the Arkansas Valley is covered by dune sand. The ground water is generally hard. Well records and logs are included.

SAND AND GRAVEL RESOURCES IN NORTHERN OHIO.

William H. Smith. 1949. 24 pp., 1 map; free. (Report of Investigations No. 6, Geological Survey of Ohio, Columbus, Ohio). The geological distribution of sand and gravel deposits is discussed in detail. Glacial features are briefly described. A map of the glacial deposits of Ohio showing the principal sand and gravel producers in northern Ohio is included with this report.

WAKEHAM LAKE AREA, SAGUENAY COUNTY.

Jacques Claveau. 1949. 58 pp., 18 pls., 2 figs., 2 maps; free. (Geological Report 37, Quebec Dept. of Mines, Quebec). The consolidated rocks of the area are Pre-Cambrian. One-half of the area is occupied by sedimentary rocks, about one-third by gabbro, and the remainder by granite. The granite forms two stocks, one along the northern boundary of the sheet, the other in the southwestern corner. Chalcopyrite deposits were found at several points.

UPPER ROMAINE RIVER AREA, SAGUENAY COUNTY.

Jacques Claveau. 1949. 36 pp., 20 pls., 1 map; free. (Geological Report 38, Quebec Dept. of Mines, Quebec). The exposed consolidated rocks of this area are Pre-Cambrian. The bedrock consists of large masses of anorthosite and granite. Appreciable amounts of ilmenite are present, in places, in the anorthosite.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 of The Earth Science Digest published monthly at Boston, Mass., for October 1st, 1949.

State of Massachusetts, ss.
County of Suffolk, ss.

Before me, a Notary in and for the State and county aforesaid, personally appeared Jerome M. Eisenberg, who, having been duly sworn according to law, deposes and says that he is the Editor of the Earth Science Digest and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, as amended by the acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Publisher, S. Albert Eisenberg, 77 Victoria Street, Revere, Mass.; Editor, Jerome M. Eisenberg, Box 28, Revere, Mass.; Managing editor, Jerome M. Eisenberg, Box 28, Revere, Mass.; Business Manager, Gertrude Roberts, Box 28, Revere, Mass.

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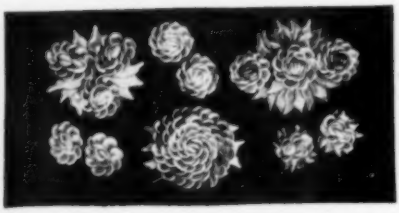

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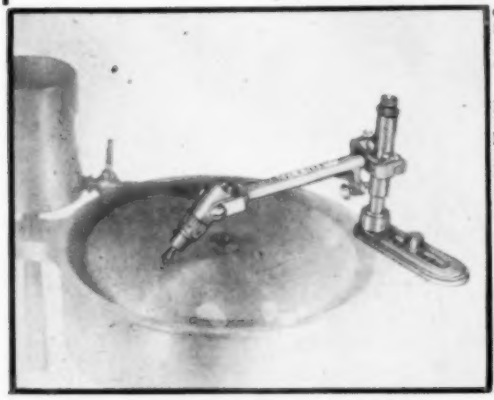

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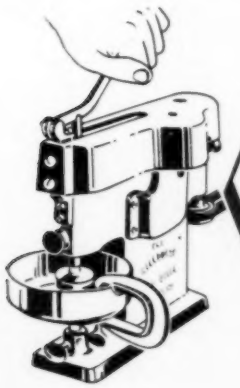

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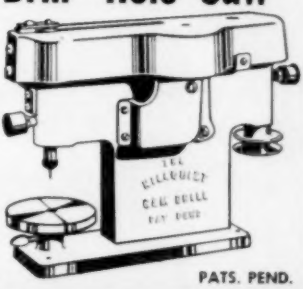

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